CT-guided transthoracic needle biopsy induced complications - how to cut back?

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Authors: T. Boskovic, M. Stojanovic, S. Pena Karan, G. Vujasinović; Sremska Kamenica/RS
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Learning objectives

CT-guided transthoracic needle biopsy is integral in the diagnosis and treatment of many thoracic diseases, and is an important alternative to more invasive surgical procedures. Although it is a widely accepted procedure with relatively few complications, precise planning and detailed knowledge of various aspects of the biopsy procedure is mandatory to avert complications.

In recent years CT-guided lung biopsy has been performed in the outpatient setting, as a way of minimizing costs and inconvenience to the patient. Thus, efforts are required to decrease complications incurred from the biopsy, and avoid patient hospitalization.

The main goal of this poster presentation is to point out frequency of complications due to this procedure, and means to reduce them.

Background

Transthoracic needle biopsy (TTNB) is percutaneous minimally invasive diagnostic procedure, for exploration of lung lesions.

Most commonly employed for imaging-guided TTNB is helical CT. The indications for transthoracic needle biopsy have altered substantially since the technique was developed, reflecting changes in many areas, including needle technology and imaging techniques. CT fluoroscopy is technical advancement which enables real-time visualization of a lesion during needle manipulation. It is reported to be more accurate than conventional CT in diagnosing pulmonary lesions, with a significant reduction in complication rates.

Most frequent complications of transthoracic needle biopsy include pneumothorax and hemoptysis. The incidence of pneumothorax in patients undergoing transthoracic needle biopsy varies from 9-54% according to reports published in the past decade. Studies show that less than 1% of patients experience significant (30 to 50 mL) hemoptysis.

Which factors statistically correlate with the frequency of complications remain controversial. To further everyday use of this procedure, solutions to the complications inherent in its performance, the commonest being pneumothorax, are necessary.
Findings and procedure details

Ideally, the technique must not only be able to diagnose malignancy but also to make a definite diagnosis if the lesion is benign.

Transthoracic needle biopsy (TTNB) can be performed, depending on a needle type, as well as type of material providing, as fine needle aspiration biopsy (FNAB), providing samples for cytology, which can accurately diagnose malignancy, while the more recent development of cutting needles (CNB), providing histological material, has enabled a firm diagnosis of benign lesions to be made, thus improving overall diagnostic accuracy. Aspiration needles are usually 20-25 gauge and provide material for cytological and microbiological examination. Cutting or core biopsy needles provide small linear tissue sections suitable for histological evaluation. These needles are usually larger in caliber than aspiration needles; however, nowadays small caliber (18-20 gauge) automated cutting needles are available.

After appropriate patient positioning, a radiopaque marker or grid is placed on the patient's skin over the area of interest to focus the optimal access point. A short spiral CT scan of the region of interest is obtained, and from these images, an appropriate table position and needle trajectory are chosen. The shortest straight pathway from the skin to the lesion is preferred over a longer oblique pathway. (Figure 1). The depth from the skin entry site to the lesion is then measured. (Figure 2)

The incidence of pneumothorax after TTNB has been reported to be from 9-54%. (Figures 3 and 4) Frequency of chest tube placement ranges from 5-18% of cases complicated by pneumothorax. Less than 1% of patients experience significant (30-50 mL) hemoptysis. Moreover, pulmonary hemorrhage is in most cases self-limited. Pneumothoraces can occur during or immediately after the procedure, which is why it is important to perform a CT scan of the region following removal of the needle, and to do a chest X-ray, usually after 1h following the procedure. (Figure 5)

Lesion size, depth, emphysema, and coagulation disorders are main factors influencing the incidence of complications after CT-guided TTNB. There is little evidence in the literature that needle gauge affects the complication rate within the size range of the smaller needles available for lung biopsy; needles larger than 18-gauge are considered a risk for causing both bleeding and pneumothorax. According to recent studies between core needle biopsies and transthoracic needle aspirations there was no statistically significant difference in complication rates between these two procedures.
Known patient-related risk factor for pneumothorax is the presence of COPD and emphysema. Most studies report a 20 to 25% incidence of pneumothorax after TTNB of the lung, with higher rates when patients have moderate-to-severe emphysema or with core biopsy. (Figure 6)

Still, many authors have found that multiple punctures have been associated with increased chances of pneumothorax and procedure failure. So to minimize complications, one should aim to puncture the pleura once only. Although the development of pneumothorax usually required abandoning the procedure, CT guided biopsy of lung lesions could be completed under stable pneumothorax if the lesion was close to the pleura.

Images for this section:
**Fig. 1:** Ct-guided transthoracic needle biopsy showing patient in lateral decubitus position with needle in mass in right hilar region.

**Fig. 2:** CT scan obtained during transthoracic needle biopsy of mass in lower left lobe, and measuring needle depth. Patient is in prone position.
Fig. 3: CT scan showing pneumothorax in lower left lobe during TTNB
**Fig. 4:** CT scan showing pneumothorax of left lower lobe, and also in interlobar fissure as needle crosses it.
Fig. 5: Post CT-guided biopsy follow up chest X-ray, showing pneumothorax of the left lung, which required chest tube placement.
**Fig. 6:** CT scan showing patient in prone position, with severe lung emphysema and high risk of developing post biopsy pneumothorax.
Conclusion

How to cut back on complications?

Many measures can be taken to help prevent the development of complications - most significant being pneumothorax and reduce the number of pneumothoraces requiring chest tube placement:

- Careful planning is necessary to traverse the least amount of aerated lung, without puncturing bullae or pneumatoceles if possible.
- Patients are instructed not to move, talk, cough, or breathe deeply during and immediately after the procedure.
- The use of a coaxial technique allows multiple specimens to be obtained with a single pleural puncture.
- To reduce the number of pleural punctures, interlobar fissures should be avoided.
- After removal of the introducer needle after the biopsy, patients should immediately be positioned in a "biopsy side down" position for at least 1 hour immediately after completing the procedure.
- Some authors also propose a new method of ipsilateral opposite-side aspiration, as it offers a solution for patients who remain with resistant pneumothorax after simple aspiration.
- Significant hemorrhage can be avoided by careful attention to technique.

Conclusion

Lung needle biopsy is typically an outpatient procedure with infrequent complications and as such has become a standard and very useful tool in the routine diagnostics of lung lesions.

The problem most responsible for prolonging outpatient management is not presence of complications, but increase in the size of the pneumothorax/hemorrhage that require patient hospitalization.

There are measures and maneuvers that can be taken to help prevent the development of complications and reduce the number patients requiring hospitalization.
All invasive procedures have a morbidity and mortality rate associated with them, which are important in considering whether to subject the patient to a procedure. Better appreciation of the technique and patients with higher risk can help cut the risk of complications to a minimum and to avoid hospitalization.

Personal information

Boskovic Tatjana, Stojanovic Milos, Pena Karan Slobodanka, Vujasinovic Gordana.

Institute for pulmonary diseases of Vojvodina, Center for Radiology, Faculty of Medicine, University of Novi Sad, Sremska Kamenica, Vojvodina, Serbia.

Corresponding to: Dr Tatjana Boskovic, Center for Radiology, Institute for Pulmonary Diseases of Vojvodina, Put dr Goldmana 4, 21204 Sremska Kamenica, Serbia. Email: tatjana.boskovic@hotmail.com.

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